

The Interaction of Monetary and Fiscal Policy: The Brazilian Case

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Abstract

We tested, empirically, whether the Brazilian fiscal policy for the period between 1995: I to 2008: III was active or passive. To analyze fiscal policy transmission mechanisms, we estimated functions by which the public debt/GDP ratio affects investment, primary surplus, output gap and the demand for money. The ratio of public debt to GDP was found to be statistically significant, positively affecting the demand for money and the primary surplus, whereas it was found to negatively affect the level of investment and the output gap. We conclude that the Brazilian regime was non-Ricardian in the context of fiscal dominance.

Keywords: Active and Passive Policies, Non-Ricardian Regime, Public Debt and Fiscal Dominance Regime

1. Introduction

Since 1999, Brazil has been under an inflation targeting regime in an environment of fiscal imbalance, illustrated by the successive nominal deficits generated in recent decades.

Despite the successive primary surpluses generated in recent years and a relatively stable ratio of public debt to GDP, the trajectory and profile of the Brazilian public debt continue to constitute a cause for concern, especially if we consider the rise in the ratio of debt to GDP after the recent bank crisis/financial crisis (subprime crisis) that has gripped the world.

The sharp reduction in the level of economic activities since the last quarter of 2008 due to subprime crisis and the strong retraction in the Brazilian output growth rates in 2009 contributed to reduce the public revenues, whereas the level of government expenditure increased.

The high interest rates imposed by the Brazilian Central Bank (BCB) in order to reach the inflation targets contribute to making the cost of servicing the debt higher than the primary surplus. Despite the recent reduction in the nominal interest rate in 2009, Brazil still has one of the highest real interest rates in the world.

Continuous growth of the nominal deficit and, con-

sequently, of the public debt, makes the fiscal imbalance particularly worrisome, due to the high public debt stock and the elevated short-term liabilities in a scenario of strong retraction of the world economy and, therefore, of the national economy.

The principal objective of this study was to test, empirically, whether fiscal policies have had, from 1995: I to 2008: III, an impact on real variables such as the real demand for money, the ratio of investment to GDP and the output gap. Hence, we aimed to investigate whether the Brazilian economy supports the Ricardian equivalence hypothesis. We also test, empirically, whether or not the monetary and fiscal policies are passive or active based on Leeper model [1].

To that end, we tested certain non-Ricardian models, such as those devised by [2-4]. In addition, we aimed to analyze the transmission mechanisms of fiscal policy by estimating the relationship between the primary surplus and public debt, as well as the “fiscal” investment-savings (IS) curve. The use of the term “fiscal” IS was based on the fact that a fiscal variable was used in the estimation. For the present study, we used the ratio of the primary surplus to GDP. We also determined whether the fiscal variable, public debt, was significant and to what extent it affected the investment rate, the output gap and

the demand for money. In other words, we analyzed whether the fiscal policy was active in the period analyzed.

The basis of this discussion is the concept of Ricardian equivalence, as proposed by [5]. The general principle of Ricardian equivalence is that the government debt is equivalent to future taxes and, if consumers are sufficiently prudent, future taxes will be equivalent to current taxes. Therefore, to finance the government by increasing the debt is equivalent to financing by raising taxes. The implication of Ricardian equivalence is that fiscal cuts financed by debt do not alter consumption. Families save the extra disposable income to pay for the future fiscal liability caused by the fiscal cuts.

This increase in private savings compensates precisely for the reduction in public savings. National savings remain unaltered. In the present study, we attempted to determine whether the public debt truly matters.

2. Monetary and Fiscal Policies: A Brief Discussion

Since the 1970s, Brazil has systematically shown internal or external macroeconomic disequilibrium. This condition generated substantial inflation. To attenuate this effect, policymakers resorted to stabilization policies. These policies frequently result in internal or external debt disequilibrium. One of the possible explanations to the debt stock disequilibrium is the possible inconsistency between fiscal and monetary policies.

The debate between monetary and fiscal policies has been restricted to the discussion between rules versus discretionary behavior. Nowadays, this discussion has mainly emphasized the inflation targeting proposals. The optimal monetary policy rule assumes that the fiscal policy is not relevant to the monetary policy. It is assumed implicitly that public debt is solvent. In other words, the fiscal authorities always adjust the taxes in order to guarantee debt solvency. In fact, in a fiduciary regime, the debt will always be solvent given that it is possible to use the seigniorage as source of revenue. With the fiscal policy neglected, the discussion about coordination between monetary and fiscal policies is weakened. In this context, some researchers place emphasis on the discussion related to the coordination between monetary and fiscal policies to keep economic stability. Sargent and Wallace [6], for example, discuss this question in their seminal work related to the unpleasant monetarist arithmetic.

Reference [6] show that if the monetary policy affects the extent to which the seigniorage is exploited as a source of revenue, then the monetary and fiscal policies should be coordinated. In this sense, the price stabiliza-

tion policy depends on the following question: who acts first, the fiscal or the monetary authority? Or, who imposes discipline on whom? The unpleasant monetarist arithmetic suggested by the authors appears in a process of policy coordination in which the fiscal policy dominates monetary policy and the monetary authority confronts itself with restrictions imposed by the demand of government bonds. This is a possible case of active fiscal policy and passive monetary behavior.

Many papers show the equilibrium policy as the result of a game between fiscal and monetary authorities. Reference [7], for example, makes the description of a Ricardian regime in which the monetary authority is the dominant player while the fiscal authority is the follower. In this sense, the fiscal authority increases the fiscal tax to satisfy the condition of budget equilibrium. This is an example of a passive fiscal policy and active monetary policy.

According to [1], what distinguishes an active policy from a passive one is the fact that the active policy takes into account the expected future while the passive one relies on the behavior of current and past values of economic variables. Thus, an active policy is not restricted by current conditions and may well include a choice of a decision rule that depends on past, current or future values of economic variables.

A passive policy or passive authority (fiscal or monetary), on the one hand, is restricted by decisions of consumer optimization and by the actions of the active authority, on the other hand. If the fiscal policy is passive, for example, the decision rule of the fiscal authority will necessarily depend on the public debt, current or past.

Reference [8] emphasizes that the discussion related to fiscal dominance is not new. It appeared in the literature in the works such as [6,9]. Reference [9] states that the price of bonds is analogous to the price level, and the nominal rate of interest is determined by the bond/money ratio and bears no close relationship to the rate of expansion of the price level. The recent developments were started with the Fiscal Theory of the Price Level (FTPL) of [10]. The studies of [1,11-18] concentrate on the discussion about coordination and interaction between the monetary and fiscal policies.

The main point emphasized by the research on the FTPL is that the intertemporal government budget constraint and the fiscal policy are the determining factors for the price level. This argument runs counter to the traditional theory of price determination, in which the stock of money and the monetary authority are the only determinant of the price level. Moreover the fiscal policy, explicitly or implicitly, passively adjusts the primary surplus to guarantee government solvency for any price level. Since the fiscal authority is free to choose the pri-

mary surplus, independently of the government debt, then it is the price level that has to adjust itself to satisfy the intertemporal government budget constraint in a way that there is only one price level compatible with the equilibrium.

The FTPL can be understood, in a simplistic way, as an application of one of the aspects discussed by [6], where the fiscal policy imposes restrictions on the extent of results from the monetary policy.

The main distinction between the classic theory and FTPL lies in the interpretation of the intertemporal government budget. According to the monetarist tradition, the government intertemporal equation is a constraint that is assured for any price level. According to the FTPL, the government intertemporal equation is an equilibrium condition determining the equilibrium price level.

The distinction between Ricardian and non-Ricardian regimes brings important implications to economic policies. Based on the Ricardian regime, a good monetary policy is a necessary and sufficient condition to guarantee low inflation. An independent central bank, with a strong institutional commitment towards price stability, should compel the fiscal authority to adopt a responsible and appropriate fiscal policy. For the non-Ricardian regime, a good monetary policy is not a sufficient condition to ensure low inflation, unless additional measures are taken into consideration to restrict the freedom of the fiscal authority.

3. Methodological Aspects

The principal source of the quarterly database regarding the period between 1995:I and 2008:III was the Instituto de Pesquisa Econômica Aplicada (IPEA)¹. The variables collected from the IPEA database and adopted in the present study, as well as their respective abbreviations (in parentheses), were as follows: money supply (M) - end of period - in millions of Brazilian Reals (R\$); GDP (Y) - market prices - in millions of R\$; nominal interest rate (R) - over/SELIC - in %; investment (I) or gross formation of fixed capital, in millions of R\$; amplified consumer price index (P); nominal R\$/US\$ exchange rate (E), as official rate, purchase price and mean; real effective exchange rate (e); primary surplus (PS) in millions of R\$, and the direct tax (τ) in millions of R\$ is given by the sum of income and land taxes. As a proxy for the public debt, we used the federal government bonds and open market operations (B), the source of which is the BCB.

We also used a dummy variable to distinguish between the period of the fixed exchange rate regime (1995: I to 1998: IV) and the subsequent period of the “flexible”

exchange rate. The real GDP was calculated according to the implicit GDP deflator. The Hodrick-Prescott filter was used in order to calculate the output gap (y) defined as the difference between the real GDP and the potential GDP (trend). A positive value indicates excess demand. To calculate the real interest rate (r) the Amplified Consumer Price Index was used. The real interest rate was calculated in the traditional manner, in which $(1 + R_t) = (1 + \pi_t)^* [1 + E_t(\pi_{t+1})]$, assuming that $E_t(\pi_{t+1}) = \pi_{t+1}$.

The estimated time series models are described in item 4. We used the Johansen cointegration test and the unit root test, as well as models of simultaneous equations, such as the generalized method of moments (GMM) with instrumental variables. The long-term equations resulting from the cointegration tests were analyzed, focusing especially on whether the public debt was significant and presented the sign expected based on the theoretical model. Other standard techniques for time series, such as tests of weak exogeneity, were also used. The econometric techniques used in the present study have been widely applied and are described in various books on the subject ([19-22]).

We used the GMM with instrumental variables to estimate a system of equations. When the variables are not stationary, one can expect specific problems regarding the conventional inference procedures based on ordinary least squares regression. Reference [20] stating that it was necessary to know whether similar problems arose in the context of two-stage least squares regression when facing such problems. This has been investigated by [23] and [24], who concluded that inferences with two-stage least squares estimators using instrumental variables were still valid, even in cases of non-stationary or non-cointegrated series. In this context, the conclusions drawn by [23,24] are also valid when the GMM is applied.

4. The Non-Ricardian Models and Their Empirical Results

In the next four subsections we estimated functions by which the public debt/GDP ratio affects investment, demand for money, primary surplus and output gap to analyze fiscal policy transmission mechanisms.

4.1. Effect of the Public Debt on Investment

Reference [2] demonstrated that it is possible to have sustainable long-term growth in a model of a sector in which generations overlap. They assume the presence of a convex technology, without redistribution of income from the older to the younger generation, with taxation via income tax and without the pure altruism of [5].

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Working with the so-called “AK” production function and assuming the hypothesis that the utility function of the agent incorporates an absolute bequest motive, reference [2] derives a clear implication of the model policy, *i.e.*, an increase in the government debt adversely affects the rate of growth of the capital stock, as exemplified in the following equation:

$$\frac{K_t - K_{t-1}}{K_{t-1}} = \frac{\delta A - 1}{1 + \delta} - \frac{B_t / K_{t-1}}{(1 + A)(1 + \delta)} \quad (1)$$

where K_t is the capital stock at the beginning of period t ; B_t is the stock of government debt bonds at the beginning of period t ; A represents technology; and the coefficient δ indicates the preferences of the agents.

This equation shows that the rate of growth of the capital stock is endogenous. In this context, the public debt as a proportion of the capital stock in the previous period adversely affects the rate of capital accumulation.

Considering that the difference between the capital stock in t and the capital stock in $(t - 1)$ is the investment ($K_t - K_{t-1} = I_t$), and that $Y_{t-1} = AK_{t-1}$, Equation (1) can be rewritten as follows:

$$I_t / Y_{t-1} = \beta_0 + \beta_1 * (B_t / Y_{t-1}) \quad (2)$$

where $\beta_0 = (\delta A - 1) / A(1 + \delta)$ and

$\beta_1 = -1 / [(1 + A)(1 + \delta)]$. The equation can then be estimated with log-transformed variables, as follows:

$$I_t / Y_{t-1} = \beta_0 + \beta_1 * (B_t / Y_{t-1}) + u_t \quad (3)$$

where the parameter β_1 shows the relationship between the ratios of debt (t) to GDP ($t - 1$) and of investment (t) to GDP ($t - 1$); β_0 is the intercept parameter; and u_t is the error (stochastic term).

We then determined whether the parameter β_1 was statistically significant, that is, whether it was different from zero, and its respective sign. If β_1 is negative and statistically significant, we can infer that the ratio of debt to GDP negatively affected the ratio of investment (t) to GDP ($t - 1$). In other words, if $\beta_1 = 0$, the hypothesis of Ricardian equivalence can be established.

We initially determined whether the aforementioned variables were stationary. In case the variables were not stationary, we attempted to determine whether they were cointegrated. The table presented in Appendix shows that both variables were non-stationary. Therefore, we needed to employ a cointegration test to determine whether the regression was validated, *i.e.*, whether or not the regression was spurious.

The Johansen cointegration test showed that there was a cointegration equation with a level of significance of 5%, as shown in the **Tables A.2** and **A.3** in Appendices.

A dummy variable was used (as an exogenous variable in the VAR model used in the present study) to distin-

guish between the period of the fixed exchange rate regime (1995: I to 1998: IV) and the subsequent period of the “flexible” exchange rate.

The resulting long-term equation showed that the parameter β_1 was statistically significant, as follows:

$$I_t / Y_{t-1} = -1.621 - 0.220 (B_t / Y_{t-1}) \quad (4)$$

(0.073) (0.116)

The values in parentheses represent the standard deviations of the respective coefficients estimated. According to the long-term equation, we observed that for each 1% increase in the ratio of debt (t) to GDP ($t - 1$) there was a 0.22% reduction in the ratio of investment (t) to GDP ($t - 1$). The negative correlation (Pearson) between these two variables was of 27.3%, at a level of significance of 5%. In addition, based on the chi-square statistic (1.819), the null hypothesis of weak endogeneity was not rejected ($p = 0.177$), *i.e.*, the ratio of debt (t) to GDP ($t - 1$) was weakly exogenous.

We observed that the public debt did affect the real variable in the economy, *i.e.*, the ratio of investment to GDP. Such empirical evidence suggests the need for a clear public policy prescription: the government should aim to reduce the ratio of debt to GDP. A reduction in the ratio of debt to GDP translates to a higher investment/GDP ratio.

4.2. Effect of the Public Debt on the Demand for Money

Reference [3] defined the real demand for money as a function of a negative relationship with the nominal interest rate and a positive relationship with output and real wealth². Real net wealth is defined using the following equation:

$$W = M/P + \beta(B/P) \quad (5)$$

where W is the value of real net wealth of private agents; β is the fraction of government bonds that private agents perceive as net wealth ($0 \leq \beta \leq 1$); B is the nominal stock of government debt bonds; Y/P is the real output; R is the nominal interest rate; P is the price level; and M is the nominal money supply. Therefore, the definition of real demand for money is given by this equation:

$$M/P = L_1(Y/P) + L_2R + L_3[M/P + \beta(B/P)] \quad (6)$$

According to [3], after dividing Equation (6) by Y/P we would have the following equation:

$$m = L_1 + L_2R + L_3(m + \beta b) \quad (7)$$

²Reference [4] employed a similar approach to the real demand for money in the context of non-Ricardian equivalence.

where $L_1 > 0$, $L_2 < 0$ and $L_3 > 0$; $m = M/Y$; and $b = B/Y$.

Equation (7) can be rewritten as:

$$m = (L_1/1-L_3) + (L_2/1-L_3)R + \beta(L_3/1-L_3)b \quad (8)$$

On the basis of Equation (8), we can define a stochastic equation:

$$m_t = \beta_0 + \beta_1 R_t + \beta_2 b_t + \eta_t \quad (9)$$

where $\beta_0 = (L_1/1-L_3)$, $\beta_1 = (L_2/1-L_3)$ and $\beta_2 = \beta(L_3/1-L_3)$.

If β_2 was statistically equal to zero, the hypothesis of Ricardian equivalence was established. We estimated Equation (10) with log-transformed variables. The table in Appendix A.1 shows that m , b and R were not stationary. The Johansen cointegration test showed that there were two cointegration equations at a level of significance of 5%, as shown in the **Tables A.4** and **A.5** in Appendices. We again used the dummy variable as an exogenous variable in the VAR model. The long-term equation showed the following:

$$m_t = -1.924 - 0.286R_t + 0.820b_t \quad (10)$$

(0.088) (0.087) (0.114)

The values in parentheses represent the standard deviations of the respective coefficients estimated. According to the long-term equation, we noted that for each 1% increase in the ratio of debt to GDP there was a 0.82% increase in the demand for money. There was a positive correlation (Pearson) of 94.2% between these two variables at a level of significance of 1%. On the basis of the chi-square statistic (15.197), the null hypothesis of weak endogeneity of the ratio of debt to GDP was rejected ($p < 0.001$). As expected, there was a negative correlation between the interest rate and the demand for money. We observed that for each 1% increase in nominal interest rate there was a 0.286% reduction in the demand for money.

4.3. Effect of the Public Debt on the Primary Surplus

Reference [25] evaluated the sustainability of the fiscal policy based on the response of the primary surplus (except for interest rates)/GDP ratio to changes in the public debt/GDP ratio. We simplified this relationship through a regression with log-transformed variables as follows:

$$PS/Y = 0.004 + 0.031 * B/Y \quad (11)$$

(0.002) (0.003)

The **Tables (A.6)** and **(A.7)** in the appendices show that both variables were I(1), and that they cointegrated

at a level of significance of 5%. The values in parentheses represent the standard deviations of the respective coefficients estimated.

According to the long-term equation, we noted that for each 1% increase in the ratio of debt to GDP there was a 0.031% increase in the ratio of the primary surplus to GDP. The positive correlation (Pearson) between the two variables was 74.7%, at a level of significance of 5%. We also observed that, based on the chi-square statistic (1.168), the null hypothesis of weak endogeneity was not rejected ($p = 0.279$), *i.e.*, the ratio of debt to GDP was weakly exogenous.

4.4. Effect of the Public Debt on the Primary Surplus and on the Output Gap

In this section, we estimated the equations of the fiscal IS and of the relationship between the primary surplus and public debt. The most appropriate method of estimating these two equations as a system was using the GMM, with appropriate instrumental variables. All variables were log-transformed. The estimation of the equation to measure the response of the primary surplus/GDP (PS/Y) ratio to the levels of the government debt/GDP (B/Y) ratio was defined as follows:

$$(PS/Y)_{t+1} = a_0 + a_1 (PS/Y)_t + a_2 (B/Y)_t + u_{t+1} \quad (12)$$

where u_t is the stochastic term.

The fiscal IS was defined as:

$$y_{t+1} = a_3 + a_4 y_t + a_5 r_t + a_6 (PS/Y)_t + a_7 e_t + \eta_{t+1} \quad (13)$$

where y_t is the output gap; r_t is the real interest rate; $(PS/Y)_t$ is the fiscal variable of interest (primary surplus/GDP); e_t is the real exchange rate; and η_{t+1} is the stochastic term.

The use of the denomination fiscal IS was due to the fact that we considered a fiscal variable in the IS curve. We assumed that the stochastic terms of Equations (12) and (13) were not serially correlated.

On the basis of this model, we identified the direct effects of the public debt on the primary surplus and the indirect effects of the public debt on the output gap. If the ratio of public debt to GDP was statistically significant in Equation (12) and the ratio of the primary surplus to GDP was also statistically significant in Equation (13), we would have an indication that the fiscal policy was active. That meant that the government debt indirectly affected a real variable (output gap) via the primary surplus.

The results presented in **Table 1** show that all variables were statistically significant to a level of 1% and that each 1% increase in the ratio of debt to GDP translated to a 0.023% increase in the ratio of the primary surplus to GDP.

The GMM applied in combination for the two equations in the form of a system, yielded the results presented in **Tables 1** and **2**. The model specification was tested using the J statistic associated with overidentification restrictions. The value of the J statistic was 0.28 ($p = 0.50$), and there was therefore no basis for rejecting the model specification.

The results presented in **Table 2** also showed that all variables were statistically significant to the level of 5%. In short run, an increase of 1% in the ratio of the primary surplus to GDP caused a reduction of 2.963% in the output gap, so that the final effect of the 1% increase in the ratio of debt to GDP was a 0.07% reduction in the current output gap. In the long term, considering the effect of the coefficient for the lagged output gap, the final effect would be a reduction of 0.31% in the output gap. This result provided empirical evidence that the fiscal policy was active.

The remaining coefficients showed the expected signs, so that each 1% increase in the real interest rate caused a 0.048% reduction in the output gap and each 1% increase in the real exchange rate caused a 0.006% increase in the output gap.

Table 1. GMM estimate using the Bartlett kernel and a fixed bandwidth: $(PS/Y)_{t+1} = a_0 + a_1(PS/Y)_t + a_2(B/Y)_t + u_{t+1}$.

Variable	Coefficient	Standard deviation	t statistics	p-value
Intercept	0.004	< 0.001	18.045	< 0.001
PS/Y	0.221	0.026	8.411	< 0.001
B/Y	0.023	< 0.001	27.670	< 0.001
R2	0.612			

Note: instruments: $y(-3, -4, -5, -6)$, $r(-3, -4, -5, -6)$, $PSY(-3, -4, -5, -6)$, $e(-3, -4, -5, -6)$, $B/Y(-3, -4, -5, -6)$, c .

Table 2. GMM estimate using the Bartlett kernel and a fixed bandwidth: $y_{t+1} = a_3 + a_4y_t + a_5r_t + a_6(PS/Y)_t + a_7e_t + \eta_{t+1} + a_2(B/Y)_t + u_{t+1}$.

Variable	Coefficient	Standard deviation	t statistics	p-value
Intercept	0.431	0.029	15.047	<0.001
Y	0.771	0.013	59.371	<0.001
R	-0.048	0.009	-5.316	<0.001
PS/Y	-2.963	0.250	-11.836	<0.001
E	0.006	0.003	2.091	0.039
R2	0.722			

Note: instruments: $y(-3, -4, -5, -6)$, $r(-3, -4, -5, -6)$, $PSY(-3, -4, -5, -6)$, $e(-3, -4, -5, -6)$, $B/Y(-3, -4, -5, -6)$, c .

5. The Leeper’s Model and the Empirical Results

The model developed by [1] defines the conditions according to which the monetary and fiscal policies may be classified as passives and/or active, where B is the government nominal debt, on which a nominal interest rate R_t is paid, τ is the direct lump-sum tax, p is the price level, $\pi_t = p_t/p_{t-1}$ and $b_t = B_t/p_t$.

The author describes government policies based on simple rules where the fiscal policy is:

$$\tau_t = \gamma_0 + \gamma B_{t-1} + \Psi_t \tag{14}$$

where Ψ_t is the exogenous shock, occurring at the beginning of t and following the AR(1) process:

$$\Psi_t = \rho_\Psi \Psi_{t-1} + \varepsilon_{\Psi t} \tag{15}$$

with $|\rho_\Psi| < 1$ and $E_t \varepsilon_{\Psi t+1} = 0$.

We believe that it makes more sense to consider direct taxes and the nominal government debt relative to GDP. Equation (14) becomes:

$$\frac{\tau_t}{GDP_t} = \gamma_0 + \gamma \frac{B_{t-1}}{GDP_{t-1}} + u_t \tag{16}$$

where u_t is the stationary AR(1).

The monetary policy also obeys a simple rule for the interest rate, that is,

$$R_t = \alpha_o + \alpha \pi_t + \Theta_t \tag{17}$$

where Θ_t is an exogenous shock, occurring at the beginning of t and following the AR(1) process:

$$\Theta_t = \rho_\Theta \Theta_{t-1} + \varepsilon_{\Theta t} \tag{18}$$

with $|\rho_\Theta| < 1$ and $E_t \varepsilon_{\Theta t+1} = 0$.

Leeper’s approach reduces the equilibrium solution of his model to a dynamic system in (π_t, b_t) and finds the roots $\alpha\beta$ and $\beta^{-1} - \gamma$. The stability condition requires one root less than or equal to one in absolute value and another greater than or equal to one. It follows that the equilibrium generates four regions of interest.

- 1) Region 1: $|\alpha\beta| \geq 1$ and $|\beta^{-1} - \gamma| < 1$. This is the case of a unique equilibrium. In this region, the Ricardian equivalency holds. In this context, the monetary policy is active and the fiscal policy is passive. This is the ideal region for the policymaker to instate a target of inflationary regime controlling the interest rate;
- 2) Region 2: $|\alpha\beta| < 1$ and $|\beta^{-1} - \gamma| \geq 1$. This region also generates a unique equilibrium. The region II represents the fiscal theory of price level (FTPL) or the regime of fiscal dominancy. In this case, one has a passive monetary policy and an active fiscal policy;
- 3) Region 3: $|\alpha\beta| < 1$ and $|\beta^{-1} - \gamma| < 1$. In this region, the fiscal and monetary authorities act pas-

sively, subject to the budget constraint. In this case, there are an infinite number of equilibrium points, which means that the equilibrium is undetermined; and

- 4) Region 4: $|\alpha\beta| \geq 1$ and $|\beta^{-1} - \gamma| \geq 1$. There is no equilibrium in this region unless the exogenous shocks, ε_{ψ_t} and ε_{θ_t} , are perfectly correlated. In this case, the monetary and fiscal policies are active.

The discussion above implies important consequences for the policy-making decisions. The optimal monetary policy rules, in the context of inflation targeting regime, assume, explicit or implicitly, that the economy is operating in Region 1.

On the other hand, if we assume that the economy is operating in Region 2, where FTPL dominates, an optimal monetary policy rule defined by the control of the interest rate via Taylor rule does not make sense. In Region 2, the price level is determined by the fiscal policy, and the monetary policy is ineffective given that it is passive. In a context of a non-Ricardian regime, reference [8] suggests an optimal fiscal rule to control inflation.

In Regions 3 and 4, coordination between the monetary and fiscal authorities is necessary to force the economy to migrate to Region 1.

In this section, we estimated two systems of equation to obtain the parameters γ and α of the Equation (16) and (17) via GMM. The first system shows the equation used by [26] to analyzing the solvency of public debt such as:

$$(B/Y)_t = a_0 + a_1Trend + a_2(B/Y)_{t-1} + a_3dummy + u_t \quad (19)$$

and the Equation (16).

The results presented in **Table 3** show that all variables were statistically significant to a level of 5% except the intercept and that each 1% increase in the lagged ratio of the debt to GDP translated to a 0.717% increase in the ratio of the current debt to GDP. In this case, eventual insolvency will occur if $a_1 \neq 0$, that is there is a deterministic trend ([26]).

Table 3. GMM estimate using the Bartlett kernel and a fixed bandwidth: $(B/Y)_t = a_0 + a_1Trend + a_2(B/Y)_{t-1} + a_4 * Dummy + u_t$.

Variable	Coefficient	Standard deviation	t statistics	p-value
Intercept	0.001	0.021	0.057	0.955
Tend	0.001	< 0.001	2.064	0.042
(B/Y)(-1)	0.717	0.043	16.847	< 0.001
Dummy	0.146	0.031	4.636	< 0.001
R2	0.968		R2 adjusted	0.966

Note: Instruments: B/Y(-3, -4, -5, -6), τ / Y (-3, -4, -5, -6), c.

The GMM applied in combination for the two equations in the form of a system, yielded the results presented in **Tables 3** and **4**. The model specification was tested using the J statistic associated with overidentification restrictions. The value of the J statistic was 0.20 (p = 0.97), and there was therefore no basis for rejecting the model specification.

The results presented in **Table 4** show that all variables were statistically significant to a level of 1% and that each 1% increase in the ratio of the lagged debt to GDP translated to a 0.005% increase in the ratio of the direct taxes to GDP. This implies that $\gamma = 0.005$.

The second system shows two equations: the IS curve and the Taylor rule. The IS equation is:

$$y_t = a_1 + a_2y_{t-1} + a_3r_{t-1} + a_4e_{t-1} + a_5Dummy + \eta_t \quad (20)$$

and the Taylor rule is defined as follow:

$$R_t = a_6 + a_7E_t(\pi_{t+1}) + a_8y_t + a_9R_{t-1} + \eta_t \quad (21)$$

where $E_t(\pi_{t+1})$ is the expected inflation rate.

The results presented in **Table 5** show that all variables were statistically significant to a level of 1% and all the coefficients showed the expected signs.

The GMM applied in combination for the two equations in the form of a system, yielded the results presented in **Tables 5** and **6**. The model specification was tested using the J statistic associated with overidentification

Table 4. GMM estimate using the Bartlett kernel and a fixed bandwidth: $(\tau/Y)_t = a_3 + a_4 * (B/Y)_{t-1} + \eta_t$.

Variable	Coefficient	Standard deviation	t statistics	p-value
Intercept	0.006	< 0.001	27.282	< 0.001
(B/Y)(-1)	0.005	< 0.001	10.035	< 0.001
R2	0.386		R2 adjusted	0.373

Note: Instruments: B/Y(-3, -4, -5, -6), τ / Y (-3, -4, -5, -6), c

Table 5. GMM estimate using the Bartlett kernel and a fixed bandwidth: $y_t = a_1 + a_2y_{t-1} + a_3r_{t-1} + a_4e_{t-1} + a_5 * Dummy + \eta_t$.

Variable	Coefficient	Standard deviation	t statistics	p-value
Intercept	0.8555	0.096	8.947	< 0.001
y_{t-1}	0.331	0.077	4.312	< 0.001
r_{t-1}	-0.236	0.031	-7.612	< 0.001
e_{t-1}	0.111	0.028	3.971	< 0.001
Dummy	0.274	0.036	7.659	< 0.001
R2	0.505		R2 adjusted	0.460

Note: Instruments: R(-2, -3, -4, -5, -6), π (-2, -3, -4, -5, -6), B/Y(-2, -3, -4, -5, -6), c.

Table 6. GMM estimate using the Bartlett kernel and a fixed bandwidth: $R_t = a_6 + a_7 * E_t(\pi_{t+1}) + a_8 * y_t + a_9 * R_{t-1} + \eta_t$.

Variable	Coefficient	Standard deviation	t statistics	p-value
Intercept	-0.315	0.054	-5.835	< 0.001
$E_t(\pi_{t+1})$	0.149	0.038	3.940	< 0.001
y_t	0.177	0.033	5.398	< 0.001
R_{t-1}	0.872	0.026	34.070	< 0.001
R2	0.789		R2 adjusted	0.775

Note: Instruments: $R(-2, -3, -4, -5, -6)$, $\pi(-2, -3, -4, -5, -6)$, $B/Y(-2, -3, -4, -5, -6)$, c

restrictions. The value of the J statistic was 0.25 ($p = 0.90$), and there was therefore no basis for rejecting the model specification.

The results presented in **Table 6** show that all variables were statistically significant to a level of 1% and all the coefficients showed the expected signs. We assume that $E_t(\pi_{t+1}) = \pi_{t+1}$. Noticing that an increase of 1% in the expected inflation rate generate an increase of 0.149% in the nominal interest rate. This implies that $\alpha = 0.149$.

The value of $\beta = 0.98$, the rate of time preference, was taken from [27]. With $\gamma = -0.005$, $\alpha = 0.149$ and $\beta = 0.98$, the Brazilian economy, in the analyzed period, was in Region 2, where $|\alpha\beta| < 1$ and $|\beta^{-1} - \gamma| > 1$. What can be concluded is that, in the analyzed period, Brazil was operating in a situation of fiscal dominance. We estimated the Taylor rule without the output gap, in according to Equation (17), and we also obtain the same result, *i.e.*, $|\alpha\beta| < 1$.

6. Conclusions

The results show that public debt plays a key role in determining variables such as the real demand for money, the ratio of investment to GDP and the output gap. In the period between 1995: I and 2008: III, we observed a positive correlation between the ratio of public debt to GDP and the demand for money normalized to the GDP. We also observed that there was a negative correlation between the ratio of public debt to GDP and the ratio of investment to GDP, and a negative correlation between the ratio of public debt to GDP and the output gap. In this context, we found empirical evidence that the Brazilian economy in the period considered did not corroborate the hypothesis of Ricardian equivalence.

In addition, it was observed that the ratio of the primary surplus to GDP during this same period reacted positively and directly to an increase in the ratio of public debt to GDP, and that the ratio of debt to GDP nega-

tively and indirectly affected the output gap via the primary surplus. Such results once again provide empirical evidence that the Brazilian economy did not conform to the regime of Ricardian equivalence.

On the basis of our findings, we can also infer that there are strong empirical evidences that the fiscal policy was active and the monetary policy was passive based on Leeper model. Reference [28] found similar results.

When there is a Ricardian regime, which implies that the monetary policy is active and the fiscal policy is passive, it is reasonable to only analyze the transmission mechanisms of the monetary policy. However, in the case of a non-Ricardian regime, in which the fiscal policy was active and the monetary policy was passive, we can and must analyze the transmission mechanisms of the fiscal policy. Therefore, we can infer that if the public debt positively affects the demand for money, it might also affect the interest rate. Given the money supply, if there is an increase in the demand for money caused by an increase in the public debt, a rise or a pressure in the interest rate is expected. Higher interest rates translate to reduce levels of investment and, in turn, reduced levels of output or an output gap. We observed that the public debt negatively affected the level of investment and the output gap. These links show how the effects of the fiscal policy are expanded or transmitted within the economy.

7. References

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Appendix

Table A.1. Unit root tests.

Variables	ADF – Modified AIC			ADF – Modified SIC		
	Critical value 5%	t-Statistic	p-value	Critical value 5%	t-Statistic	p-value
L(m)	-2.927	-1.701	0.424	-2.921	-2.196	0.210
L(R)	-2.919	-2.506	0.120	-2.919	-2.506	0.120
L(b)	-3.502	-2.145	0.509	-3.495	-2.518	0.319
L(I/Y-1)	-2.924	-0.723	0.831	-2.924	-0.723	0.831
L(B/Y-1)	-1.949	-0.916	0.314	-1.947	-0.506	0.821
L(PS/Y)	-2.919	-0.929	0.771	-2.919	-0.929	0.771

Note: L = Log.

Table A.2. Johansen cointegration test: L(I/Y-1) = f [L(B/Y-1)].

Hypothesized N° C.E. (s)	Eigenvalue	Trace Statistic	0.05 Critical Value	p-value
None*	0.333	29.388	20.262	0.002
At most 1	0.157	8.726	9.164	0.060

Note: Trace test indicates 1 cointegrating equation at the 0.05 level. (*) = denotes rejection of the hypothesis at the 0.05 level.

Table A.3. Johansen cointegration test: L(I/Y-1) = f [L(B/Y-1)].

Hypothesized N° C.E. (s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	p-value
None*	0.333	20.662	15.892	0.008
At most 1	0.157	8.726	9.164	0.060

Note: Max-Eigenvalue test indicates 1 cointegrating equation at the 0.05 level. (*) = denotes rejection of the hypothesis at the 0.05 level.

Table A.4. Johansen cointegration test: L(M/Y) = f [L(R), L(B/Y)].

Hypothesized N° C.E. (s)	Eigenvalue	Trace Statistic	0.05 Critical Value	p-value
None*	0.520	62.742	35.193	<0.001
At most 1*	0.262	23.825	20.262	0.016
At most 2	0.136	7.744	9.164	0.092

Note: Trace test indicates 2 cointegrating equation at the 0.05 level. (*) = denotes rejection of the hypothesis at the 0.05 level.

Table A.5. Johansen cointegration test: L(M/Y) = f [L(R), L(B/Y)].

Hypothesized N° C.E. (s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	p-value
None*	0.520	38.917	22.299	<0.001
At most 1*	0.262	16.081	15.892	0.047
At most 2	0.136	7.744	9.164	0.092

Note: Max-Eigenvalue test indicates 2 cointegrating equation at the 0.05 level. (*) = denotes rejection of the hypothesis at the 0.05 level.

Table A.6. Johansen cointegration test: L(PS/Y) = f [L(B/Y)].

Hypothesized N° C.E. (s)	Eigenvalue	Trace Statistic	0.05 Critical Value	p-value
None*	0.532	47.908	20.262	<0.001
At most 1	0.150	8.434	9.164	0.070

Note: Trace test indicates 1 cointegrating equation at the 0.05 level. (*) = Denotes rejection of the hypothesis at the 0.05 level.

Table A.7. Johansen cointegration test: L(PS/Y) = f [L(B/Y)].

Hypothesized N° C.E. (s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	p-value
None*	0.532	39.474	15.892	<0.001
At most 1	0.150	8.435	9.164	0.070

Note: Max-Eigenvalue test indicates 1 cointegrating equation at the 0.05 level. (*) = Denotes rejection of the hypothesis at the 0.05 level.